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2,803,729

RESISTORS

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Fig. 1



Fig. 2



Fig. 3



Fig. 4

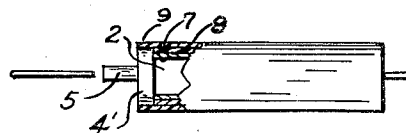


Fig. 5

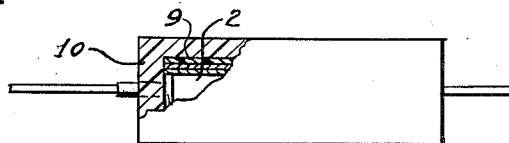


Fig. 6

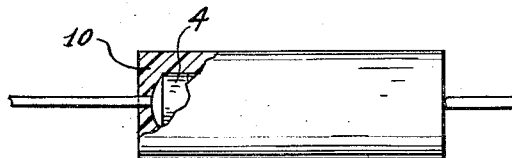


Fig. 7

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RESISTORS

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9 Claims. (Cl. 201—63)

Resistors are largely made by winding suitable wire on a core or by providing a carbon coating, and supplying terminals. A particularly important desideratum in a resistor is that it maintain an unchanged high stability, and that it have a low temperature coefficient, straight line voltage characteristic, and be capable of taking care of high as well as low wattage. Such a combination of properties has not been ideally attained. The present invention approaches the problem from a different footing, and makes possible the attainment of a desired combination of properties, applicable with resistors of various values, which also are of high precision. Other objects and advantages will appear from the following description.

To the accomplishment of the foregoing and related ends, said invention, then, comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawing setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principle of the invention may be employed.

In said annexed drawing:

Fig. 1 shows a side elevational view, partly sectional, of a resistor in the first stage of construction;

Fig. 2 shows in exploded form, collective elements for assembly;

Fig. 3 shows in side elevational view, partly sectional, another form;

Figs. 4 and 5 show in similar views a further stage of construction;

Fig. 6 shows a finished resistor; and

Fig. 7 similarly shows a slight modification.

In general, the kind of resistors here contemplated involve an insulation core with a vacuum-deposited coating of metal thereon. Less desirably the metal may be deposited by being plated on electrolytically or chemically in some cases. The core may be of ceramic, steatite, glass, thermo-setting or thermo-plastic synthetic resin, rubber, fluor-compound resins, viz., polytetrafluoroethylene, polychlorotrifluoroethylene, and the like (e. g., "Kel-F," "Teflon"), etc., as preferred in any given instance. The vacuum-depositing of the metal follows the known technique, the metal being vaporized, as by electric means, and in a vacuum-chamber, such as those commercially available as produced by Distillation Products company and generally well known technique, as for instance "Vacuum Technique" by Saul Dushman (Pub. by John Wiley & Sons, Inc. N. Y. 1949) pgs. 757-764. The vaporized metal is thus deposited on the resistor cores. Metals which may be used are for instance nickel, iron, chromium, cobalt, silver, gold, platinum, iridium, aluminum, zinc, copper, alloys of two or more such, etc. And a further feature is the simultaneous applying of combinations selected from such metals, it thereby being possible to effect a highly advantageous make-up alloyed adaptation to particular resistance values desired. Thus, for example co-depositing of such metals as nickel and silver, iron, etc., gives a resistance of values as desired, with advantages over either alone, and the relative

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amounts of the metals vaporized determine the net result. Furthermore, I take advantage of the different thermal expansion coefficient of different metals, to change or reduce the total expansion action. Thus, by depositing alloying ingredients the thermal coefficient may be adjusted as desired. Also I attain novel results by separately depositing a layer of a metal which has one rate of thermal expansion, such as nickel, iron, etc., on the resistor core, and then superposing a deposit of a metal having a different heat expansion coefficient, such for instance as manganese, zinc, etc., the net result is that when operating under load and at the temperature thereby produced, substantially no undesirable expansion occurs. More than two different layers can be applied. Metals of different thermal coefficient which can be applied either by one coat alloying as above or by applying separate coats of the differing metals, are for instance nickel, iron, chromium, platinum, iridium, tungsten, tantalum, in low thermal coefficient range; and copper, silver, in intermediate range; and manganese, aluminum, zinc, in relatively high range of thermal coefficient. And, it is to be particularly noticed that combinations, such as of iron and nickel give remarkably low thermal coefficient, such that nickel contents proportioned to around 36 percent, have substantially no expansion under heat. This makes possible the construction of a resistor with metal resistance element capable of very heavy duty and heat production, and without expansion damage to its structure or encasing. Such combinations also as platinum and iridium, and tungsten and cobalt are in a low thermal coefficient range.

While in some cases the core as coated completely with the deposited metal may be used, and adjustment to precision resistance value may be made by removal, as by grinding off a sufficient small portion; in other cases the coating may be cut or ground spiral-wise so as to give an increased length of path, as shown in Fig. 2, and at the same time adjust to precision. The structure as of Fig. 1 having the core 2 with metal coating 3 is then provided with end caps 4. While these may in some cases have already attached terminals, as in Fig. 2, it is advantageous in many instances to have at least one separate terminal which can be inserted subsequently. Generally, there is adequate contact between the applied end cap and the metal resistance coating even though not complete all around, but where desired there may be interposed a small amount of plastic silver or colloidal silver composition to increase contact, and also holding. End cap construction with an opening for terminal insertion is illustrated for instance at Figs. 3 and 5, such involving a disk 4' of conductive metal having a hollow hub 5 into which a terminal may subsequently be inserted and soldered. It is noticed that the hub 5 opens to the interior, to be used for a purpose detailed further on. The other end need not have an opening and may involve a similar disk 4'' but with attached terminal 5' and this may have a short interior knurled or cross-ribbed projection 6 for union where the core is formed by molding or for cementing in if the core is preformed before assembling the ends.

It is noticed that by selecting materials such as the fluorinated ethylene resins for the core, and low thermal expansion metals for the resistance coat element, heat developed in heavy current loads is without substantial expansive effect, nor is the core injured.

With the assembly of the caps completed, there is next applied a relatively thin cover 9 which bridges across from cap to cap, and which preferably is pliant. Suitable materials for such cover are polyethylene, and less desirably polyvinyl compositions, regenerated cellulose, etc.; and in some cases the cover instead of being pliant may be a preformed stiff shell. In any case, the cover 9 fits

on the end caps and covers over the resistance between.

The structure having for instance layers 7 and 8 of different metals and the envelope 9 is placed in a space-providing mold and liquid insulation composition is supplied to form an outside encasement. Compositions such as synthetic resins, phenol-aldehyde, polystyrene, etc., are particularly suitable, and by applying heat, 100-400° C. depending upon the particular composition, a solid encasement is formed, the completed structure then as in Fig. 6 involving the resistance-coated core 2 within the cover 9 and the whole surrounded by the insulating encasement 10. Where desired, the cover 9 and included permanently fluid insulative material may be omitted, in which case the finished resistor, as in Fig. 6, involves the structure with the end caps 4 and the overall encasement 10.

As a further refinement of the invention, by vacuum connection or chamber, air within is withdrawn from the envelope or cover 9 through one end opening left, as the aforesaid open hub 5, then a permanently fluid insulative material, such as oil, helium, nitrogen or other inert gas is supplied to replace the vacuum, and the remaining terminal is inserted in the hub and soldered in.

By applying a metal deposit over the exterior surface of the synthetic resin encasement, as may be advisable in some instances, the synthetic resin is further protected against moisture and fungus penetration if used in tropical regions, and is also protected against loss of plasticizing ingredients, and any deterioration from atmospheric or chemical fume exposure. In applying such outside metal, precaution is to be taken to mask the extending terminals by temporary application of wax or a water glass composition with filler, thereby preventing shortcircuiting by the metal. The masking is of course removed after the metal-application is completed.

As an example: A core is formed of polychlorotrifluoroethylene, and this in a vacuum chamber is subjected to a vacuum depositing of nickel, and then a deposit of silver. End caps are assembled, one having an open hub, and the other an extending terminal. The resistance value is adjusted by slight grinding away of the metal as required. A tubular cover of polyethylene is drawn over the whole from end cap to end cap, an encasement overall of polystyrene is cast or molded on and is set by heating, and a vacuum is applied and then helium to fill any interstitial spaces within, and a terminal is placed in the hub and soldered.

As another example: A coat of iron is deposited on a suitable insulation core, and then a coat of nickel is deposited. The construction is completed as in the foregoing.

As another example: A core is provided, in the manner of the foregoing, and in a vacuum chamber two metals are simultaneously applied under vaporization, one being nickel in about 35 percent proportion, and the other iron containing about 0.2 percent carbon. The resistor is then completed as foregoing.

As another example: On a suitable core there is vacuum-deposited an alloy of nickel about 20 percent, zinc about 5 percent, and remainder copper. The so-applied resistance element is adjusted to desired value by grinding, and terminals are applied, and an encasement of phenol-aldehyde resin is formed overall.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims or the equivalent of such be employed.

I therefore particularly point out and distinctly claim as my invention:

1. In making resistors, forming a stable resistor by the coordinated operations of applying deposited metal in successive coats of different metals to an insulation core, adjusting to desired resistance value by removal of minor portions of the metal as appropriate, applying end caps,

one having an opening to the interior, applying a relatively thin preformed cover of insulation over the resistance from end cap to end cap, withdrawing air from within and supplying a permanently fluid insulative material, closing the cap, and molding on an insulation encasement overall.

2. In making resistors, applying to an insulation core having a low thermal coefficient, deposited metal coating of low thermal coefficient, adjusting to desired resistance value, applying end caps, one having an opening to the interior, applying a relatively thin preformed cover of insulation over the resistance from end to end, withdrawing air from within and supplying a permanently fluid insulative material, closing the cap, and molding an insulation encasement overall.

3. In a resistance, an insulation core substantially without heat-expansibility, a deposited metal resistance element substantially without heat-expansibility thereon, a preformed thin cover of insulation over the resistance from end to end, a permanently fluid insulative material within, and an insulation encasement overall.

4. In making resistors, condensing metal vapor in a vacuum on an insulation core, adjusting to desired resistance value by removal of metal as appropriate, applying end caps, one having an opening to the interior, applying a relatively thin preformed cover of insulation over the resistance from end cap to end cap, withdrawing air from within and supplying a permanently fluid insulative material, closing the cap, and molding on an insulation encasement overall.

5. In making resistors, forming a resistance element of selected low thermal expansion coefficient by vaporizing a metal in vacuum, condensing a film thereof on an insulation core, vaporizing another metal in vacuum, and condensing a film from the vapor on the first film.

6. In a resistor, the combination of an insulation core, a plurality of deposited metal coats thereon, end caps contacting the metal, one cap having an opening to the interior, a relatively thin preformed cover of insulation over the resistance from end to end, a permanently fluid insulative material within, and an insulation encasement overall.

7. In a resistor, the combination of an insulation core of low thermal coefficient, a resistance element thereon of deposited metal of low thermal coefficient, end caps contacting the metal, one cap having an opening to the interior, a relatively thin preformed cover of insulation over the resistance from end to end, a permanently fluid insulative material within, and an insulation encasement overall.

8. In a resistor, the combination of an insulation core, a plurality of superimposed coats of different metals thereon, end caps contacting the metal, a pliant preformed cover of insulation closely fitted over the resistance from end to end, and an insulation encasement overall.

9. In a resistor, the combination of an insulation core, a plurality of superimposed coats of different metals thereon, a relatively thin preformed cover of insulation over the resistance from end to end, a permanently fluid insulative material within, and an insulation encasement overall.

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